(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁷: H04N 7/26

(21) International Application Number: PCT/US00/42581

(22) International Filing Date: 6 December 2000 (06.12.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/169,872   9 December 1999 (09.12.1999)   US
09/685,447   11 October 2000 (11.10.2000)   US

(71) Applicant: GENERAL INSTRUMENT CORPORATION [US/US]; 101 Tournament Drive, Horsham, PA 19044 (US).

(72) Inventor: ELSTERMANN, Erik, John; 1217 Belleflower Road, Carlsbad, CA 92009 (US).

(74) Agent: LIPSITZ, Barry, R.; Law Offices of Barry R. Lipsitz, Building No. 8, 755 Main Street, Monroe, CT 06468 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
—   Without international search report and to be republished upon receipt of that report.

(54) Title: NON REAL-TIME DELIVERY OF MPEG-2 PROGRAMS VIA AN MPEG-2 TRANSPORT STREAM
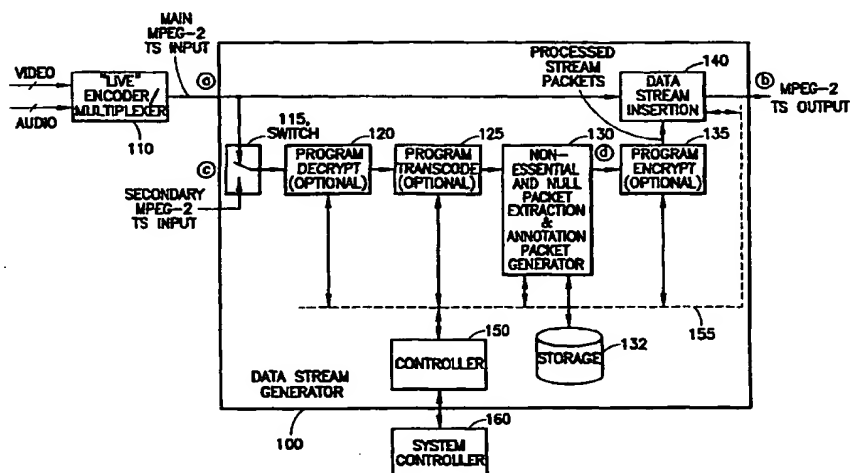
(57) Abstract: Digital content is extracted from single and multiple-program transport streams for subsequent non-real-time (background) transmission in a bandwidth-efficient manner. The content of the transport streams may include anything from targeted commercial advertisements to broadcast full-length movies. At an encoder (100), several null and/or nonessential (N/N) packets (e.g., packets of unused programs) in a transport stream are replaced by an annotation packet (AP) to obtain non-real-time packets (410). The non-real time packets are inserted into null packet locations (NU) of a real time transport stream. At a decoder (200), the annotation packets are used to regenerate a specified number of null packets to maintain the original separation of packets of the non-real time data (for timing purposes), allowing existing hardware and/or software to decode the selected program. Optionally, the non-real-time packets provide pre-encrypted programs, and decryption information is distributed to the decoders at a formal program release time specified by the program provider.

WO 01/47281 A2

NON REAL-TIME DELIVERY OF MPEG-2 PROGRAMS
VIA AN MPEG-2 TRANSPORT STREAM

BACKGROUND OF THE INVENTION

This application claims the benefit of U.S.
5   Provisional Application No. 60/169,872, filed December
9, 1999.

The present invention relates to digital
television, and more particularly to a method and
apparatus by which MPEG-2 programs or the like may be
10   extracted from a transport stream and delivered via
the same or another transport stream at a fraction of
the program's original transport rate, or stored using
less capacity than required to store the original
transport stream. In this manner, the invention
15   enables a receiving device to receive, store, and
decode the program at some future, user-initiated
time.

In bandwidth-limited systems, a tradeoff exists
between the number of digital TV programs that may be
20   delivered concurrently and their subjective quality.
A need may also exist to allow the delivery of
programs in non-real-time as enhanced services which
do not impact the quality of programs delivered in
real-time. Such enhanced services could include
25   commercial advertisements that are applicable to the
receiving device and "played out" by remote control
(e.g., during a commercial break). Moreover, it would

be advantageous to provide a capabilility to deliver programs requested by the user of the receiving device on a non-real-time basis, i.e., after the original real-time transmission of a program.

5   In the past, the issue of picture quality versus the number of programs to be carried over a given bandwidth has been addressed by employing statistical multiplexing (see, e.g., U.S. patent 5,216,503 to Paik et al.). Services such as video-on-demand have also

10   been provided where the bandwidth necessary to convey such information is accomodated by additional physical channels.

Various schemes for selecting between different real-time television signals are also known in the

15   prior art. For example, U.S. patents 5,155,591 and 5,231,494 describe targeted advertising that is delivered in real-time. Such advertising may be selected by a decoder employing customer "profiles" , as disclosed in U.S. patent 5,758,257. However, such

20   schemes are predicated on the transmission of concurrent real-time (analog and digital) TV programs.

U.S. patent 5,619,337 describes a system for recording MPEG-2 transport streams. The goal is to address the recording of a single program stream

25   extracted from a multi-program transport stream onto a device such as a digital VCR for subsequent playback.

It would be advantageous to provide a bandwidth-efficient system for conveying digital television programs and/or other content (e.g., multimedia) in

30   their original format, which may comprise, for

example, MPEG-2 transport packets. The system should allow the programs and other content to be provided on a non-real-time basis for later use by a recipient. Such content should be able to be easily received, recorded on a digital VCR or otherwise stored, and played back at the user's convenience. It would be still further advantageous to permit the communication of multiple digital TV programs and/or other content with little or no impact on the quality of real-time programs delivered via the same transport stream.

The system should enable the delivery of pre-encrypted content to one or more decoders in non-real-time, wherenin authorization data is provided to the decoders at a common time to enable decryption and playback.

The present invention provides a method and apparatus enjoying the aforementioned and other advantages.

SUMMARY OF THE INVENTION

The present invention makes use of allocated
bandwidth and/or bandwidth made available by variable
bit rate (VBR) program streams to provide a bandwidth-
5   efficient scheme for conveying content such as digital
television programs and/or multimedia information in
their original form (e.g., MPEG-2 transport packets).
A large portion of currently available MPEG-2 decoder
hardware and/or software may be used to decode content
10   delivered per the invention. The invention also, in
effect, allows the delivery of multiple non-real-time
digital TV programs and other content with little to
no impact to the quality of content delivered in real-
time via the same transport stream.

15   A particular method in accordance with the
invention provides data of at least a first program of
a first data stream in an input transport stream,
where the transport stream includes data of at least a
second data stream. The method includes the steps of:
20   extracting null packets and/or nonessential packets of
the first data stream, providing an annotation packet
that provides information regarding the extracted
packets, and inserting the annotation packet and
program packets of the first program into the input
25   transport stream in place of null packets of the
second data stream to form an output transport stream.

A decoding method is provided for processing an
output transport stream that includes data of at least
a first program and a second data stream. The method

includes the steps of: recovering program packets of
the first program, storing the recovered packets at a
storage device, recovering an annotation packet from
the output transport stream, and regenerating a number

5   of null packets of the first program based on the
recovered annotation packet to provide regenerated
data that is suitable for decoding. The output
transport stream is formed at an encoder by extracting
null packets and/or nonessential packets of a first

10   data stream that carries the first program, and
inserting the annotation packet and the program
packets of the first program into an input transport
stream in place of null packets of the second data
stream. The annotation packet provides information

15   regarding the extracted packets.

        Corresponding apparatuses are also presented.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a Data Stream Generator in accordance with the invention.

FIG. 2 is a block diagram of a Data Stream Player in accordance with the invention.

FIG. 3 depicts an example of an MPEG-2 transport stream prior to, and after, processing by the Data Stream Generator in accordance with the invention.

FIG. 4 illustrates the transport streams and data provided at various points in FIG. 1, including the use of annotation packets, in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention may be implemented using two key elements, namely a Data Stream Generator/encoder and a Data Stream Player/decoder.
5 The Data Stream Generator, which is responsible for extracting real-time programs, storing them and re-inserting them as non-real-time data, can exist as a standalone product for use, e.g., with any MPEG-2 encoder or multiplexer, including the DigiCipher® II
10 encoder products available from a division of Motorola Corporation that was formerly known as General Instrument Corporation, Horsham, Pennsylvania, U.S.A. MPEG-2 is described in ISO/IEC IS 13818-1, International Standard, MPEG-2 Systems. The invention
15 can also be used with data that is provided according to, e.g., Draft ATSC Data Broadcast Specification, ATSC T3/S13 Doc. 010, Rev. 0.20, 9-Feb-99, DVB Specification for Data Broadcasting, ETSI EN 3-1 192 V1.1.1 (1997-12), or other digital packetized data
20 formats.

Furthermore, the invention can be implemented in hardware, firmware, software, or any combination thereof. Additional processing such as transcoding (to reduce the bit rate of the original programs) can
25 also be applied to reduce the delivery time of program data to the receiving device, reduce the required storage capacity, and/or to allow for multiple programs to be delivered concurrently.

The Data Stream Player may comprise, e.g., an MPEG-2 decoder or decoder enhancement which receives the transport stream, extracts and stores the data stream (based on criteria established by its user or

5   the transport stream provider), and decodes the data stream when initiated by the user or transport stream provider.

Moreover, the Data Stream Generator and Player can employ access control whereby the non-real-time

10   data may only be decoded when the proper authorization is provided to the Player, even if the non-real-time stream has already been delivered and stored. Content can then be securely provided (e.g., by using entilement control messages - ECMs) in advance of its

15   "official" release, allowing the content to be immediately played in its entirety upon official release. In this manner, for example, new releases of digital movies and other premium entertainment can be delivered in advance for later viewing. The present

20   invention can also deliver content such as targeted advertisements, news and the like in non-real-time to a decoder for subsequent playback based, for example, on a customer profile.

The present invention, and in particular the use

25   of "annotation" packets as described hereinafter, can also be used to facilitate the recording of digital content on a digital VCR or the like, as it reduces content storage requirements and allows additional information to be conveyed about the content. Such

30   information can be used, for example, to facilitate

playback control (e.g., targeted ad profile data,
location of I-frames for fast forward/rewind
functions, etc.), and for transmission error handling.

FIG. 1 illustrates a Data Stream Generator (DSG)
5   100 in accordance with the invention. A main
transport stream (TS) input, provided from audio/video
data at a "live" encoder/multiplexer 110, and,
optionally, at least one secondary TS input, are
provided to the DSG 100. A switch 115 provides either
10   the main or secondary TS input to an optional program
decryption function 120 and an optional program
transcode function 125. The transcode function 125 is
used when it is desired to reduce the bit rate of the
input program. Decryption is used when an encrypted
15   input is received and it is desired to transcode it.

A nonessential and null packet extraction and
annotation packet generator 130 removes nonessential
and/or null packets from the input program and forms
corresponding annotation packets in accordance with
20   the invention. Null packets are inserted at an
encoder to maintain a desired bit rate, whereas the
nonessential packets may include other program packets
that are not used. For example, a TS may be
distributed nationally by satellite to a number of
25   different headends of a cable television network.
Each network may have its own progam line up that does
not use all of the received programs. The unused
program are therefore nonessential to that associated
network.

The annotation packets provide information regarding the null and/or nonessential packets by providing information that decribes them, such as the number of null and nonessential packets. Preferably,

5 one annotation packet provides information for several null nonessential packets. Successove annotation packets are used for successive respective groups of null and/or nonessential packets. An associated storage device 132 may store the processed stream with

10 the annotation packets.

The program packets (e.g., comprising audio and video data) and annotation packets are output from the function 130 to an optional program encrypt function 135. These packets together form a processed or

15 condensed data stream, which is a condensed version of the packets that were output from the switch 115. At a data stream insertion function 140, the packets of the processed stream are inserted into the main TS, e.g., using multiplexing. Specifically, the processed

20 stream packets replace null packets of the main TS input. Thus, there is no loss of important data in the main TS.

Note that the processed stream may be inserted back into the TS from which it was derived. For

25 example, when the switch passes the input from path "a", the processed stream is derived from the main TS input, and is inserted back into the main TS input. Or, the processed stream may be derived from the secondary TS input (path "c") and inserted into the

30 main TS input.

11

The components of the DSG 100 are under the
control of a central controller 150, e.g., via a bus
155. The controller 150, in turn, may be responsive
to a system controller 160, e.g., that receives an

5   operator input. For example, an operator may set
parameters for transcoding, decryption and encryption,
or to specify nonessential programs, e.g., according
to a PID.

The DSG 100 extracts content (e.g., MPEG-2 video)

10   from any of its MPEG-2 transport stream inputs, which
can be "live" (e.g., received from a broadcast) or
"off-line" (e.g., retreived from storage), processes
the data (as described below), and replaces null
packets present in the "live" transport stream with

15   the processed, non-real-time data. This processed
data may be delivered over an indefinite period, e.g.,
using carouseling, which involves periodic, repeated
transmission of data.

FIG. 2 illustrates a Data Stream Player (DSP)

20   200, also according to the invention. The DSP 200 may
be embodied as a set-top box decoder or the like at a
user's location. The DSP 200 receives a transport
stream (TS) input, such as the TS at path "b" in FIG.
1, at a data stream retrieval function 210 and at a

25   switch/splicer 250. The TS includes real-time program
packets of one or more programs (e.g., channels or
services), along with the non-real-time insertion
stream packets, including the annotation packets
thereof. The data stream retrieval function 210

extracts the non-real-time program data and associated annotation packets for storage.

The program player 230 performs the function of regenerating null packets to limit the amount of storage 220 required. In particular, the player 230 analyzes the annotation packets to regenerate a number of null packets based on the number of null and/or nonessential packets that are described by the associated annotation packets. Error handling procedures may also be applied, as discussed elsewhere. The regenerated stream is forwarded to a storage device 220 for subsequent retrieval. Successive portions of the stream may be stored while additional portions continue to be received and processed at the function 210. A program player 230 initiates playback of the stored data at the storage device 220, e.g., in response to a user request, by forwarding the data to the switch/splicer 250, with optional decryption, if required, at a program decryption function 240.

In a switch mode, the switch/splicer 250 provides either the original TS input or the retrieved program data to a demux 260 for subsequent processing at a video decoder 270 and an audio decoder 280. The demux routes the video and audio packets to the appropriate decoder and, may also demux specific program packets of the TS, e.g., according to a PID and a desired channel that is tuned by the user.

In a splice mode, the switch/splicer 250 splices packets of the retrieved insertion stream with the TS

input.   Splicing may be performed by using splice
messages ("cues") present in the real-time or non-
real-time program streams.   Switching implies a "hard-
switch" that may result in a brief, noticeable

5   disruption (e.g., picture roll, audio pop, etc.).

        A user interface 290 is provided for allowing the
user to tune or playback desired programs.

        Thus, in addition to supporting the decode and
display of "live" (e.g., real-time) programs, the Data

10   Stream Player 200 retrieves selected non-real-time
programs and stores them for future playback.   The
storage and playback may be initiated locally or
remotely, depending on the application.   For example,
in the case of movies, the user of the Data Stream

15   Player 200 may specifically select which programs to
store and view, e.g., via the interface 290.   In the
case of advertisements delivered as MPEG-2 programs,
the content provider (e.g., transport stream supplier,
network operator or the like) may want to specify

20   which advertisements are stored and viewed, based on
the attributes of the Data Stream Player (e.g.,
location of the player 200, user preferences, user
demographics, etc.)   A content provider control
function 295 may be used to communicate with the

25   content provider for this purpose.

        As show in FIG. 2, the Data Stream Retrieval
function 210 retrieves and stores the selected program
data stream (including annotation packets) from the
input transport stream.   It may make use of the

30   annotation packets to replace erroneous packets.   At a

14

time specified by the Data Stream Player user or the
content provider, the Program Player 230 extracts a
selected program data stream from storage, determines
the original transport stream rate of the program, and

5   clocks packets out at that rate. This is accomplished
using information contained in the annotation packets
to regenerate the null packets of the original
transport stream, thereby allowing existing hardware
and/or software to decode and display the selected

10   program. The Program Decryption function 240 may also
be employed to decrypt the program after it is
generated by the Program Player 230, allowing the
program to be stored in its encrypted form until the
appropriate entitlements are provided by the content

15   provider, e.g., using known access control techniques.
This allows sensitive material to be securely
delivered prior to the time of its intended use.

     Note that the Data Stream Generator and Data
Stream Player described herein may be combined to

20   provide an efficient method for storage and playback
of programs obtained from single and multi-program
transport streams.

     FIG. 3 depicts an example of a transport stream
prior to and after processing by the DSG 100. An

25   instantaneous bit rate versus time is shown. A total
instantaneous bit rate prior to a data insertion time
335 is the sum of bit rates for a component 305 that
includes program-specific information, system
information, other programs, etc., real-time program

30   data 310 (e.g., including audio and video), and null

and other nonessential data 330. After the data
insertion time 335, the total instantaneous bit rate
is the sum of bit rates for the data component 305,
real-time program data 310, and the inserted non-real-
5   time program data 340. Note that the real-time
program data may transition between successive events
(e.g., programs, commercials, news announcements, and
the like).

In this example, the video stream for the real-
10   time program(s) is depicted as a variable bit rate
(VBR) stream, with peaks and valleys in the
instantaneous bit rate that occur based on factors
such as picture complexity, picture coding type and
the like. However, the invention may also be used
15   where the real-time program(s) have a fixed bit rate
allocation.

Moreover, although only one non-real-time data
stream is shown, the DSG may deliver multiple
substantially concurrent non-real-time data streams in
20   its output. Additionally, these data streams may have
fixed and/or variable bit rates.

Also, note that the figure is not to scale, as
there are typically a number of real-time channels in
a TS, such that the region 305 consumes a larger
25   proportion of the TS's bandwidth than indicated.
However, the invention is suitable for use when there
is only one real-time channel in a TS.

FIG. 4 illustrates the transport streams and data
provided at various points in FIG. 1 in accordance
30   with the invention. As shown in FIG. 1, the DGS 100

16

replaces MPEG-2 null and other nonessential packets
received via input "a" with processed program data
received via input "a" and/or input "c". As
mentioned, the Nonessential and Null Packet Extraction
5   and Annotation Packet Generator function 130 replaces
nonessential and null packets with annotation packets,
and provides the resulting processed stream to the
storage device 132 and/or the Data Stream Insertion
function 140, which replaces null packets received at
10   input "a" with this processed stream data.

As an example, FIG. 4 illustrates the transport
streams and data provided at points "a", "b", "c", and
"d" of FIG. 1. The data 400 represents the real-time
TS at "a" or "c", e.g., for a first event (e.g., a
15   program, commercial, etc.) The data 410 represents
non-real-time insertion data for the first event which
is formed from processing the data 400. The data 420
represents a real-time TS at "a", e.g., for a second
event. The data 430 represents a real-time TS at "b"
20   which is formed from inserting the packets of the data
410 in place of null packets of the data 420.

Each packet includes an identifier indicating
whether it is a video packet "V", an audio packet "A",
a null and/or nonessential packet "N/N", a null packet
25   "NU", or an annotation packet "AP". Additionally, the
subscripts indicate a transport stream, and a packet
sequence for that type of packet in the TS. For
example, $V_{1,2}$ designates a second video packet in a
first TS.

Each packet may be an 188-byte MPEG packet, although other packet formats and sizes may be used.

The data 410 comprises the video and audio packets from the stream 400, and also provides an
5 annotation packet $AP_{1,1}$ that describes, and substitutes for, the null and/or nonessential packets $N/N_{1,1}$ through $N/N_{1,7}$. $A_{1,3}$ is the last packet covered by $AP_{1,1}$. That is, in a specific example, the annotation packet provides information regarding any null and/or
10 nonessential packets in a group of, e.g., eighteen packets in the data 400. The data 410 is essentially a condensed version of the data 400.

A subsequent annotation packet $AP_{1,2}$ describes a susbsequent number of null and/or nonessential packets
15 in a subsequent group of packets of the data 400, starting at $N/N_{1,8}$ …

The null packets in the stream 420 are replaced by the video and audio packets, and the annotation packet $AP_{1,1}$ from the stream 410. In particular, as
20 shown at 430, $V_{1,1}$ replaces $NU_{2,1}$, $V_{1,2}$ replaces $NU_{2,2}$, and so forth. The video and audio packets of the second TS, $V_{2,1}$ through $V_{2,5}$, and $A_{2,1}$ through $A_{2,3}$, respectively, are maintained in the stream 430 at the same position as in the stream 420.

25 In FIG. 4, the shaded packets represent the non-real time, insertion packets.

Each annotation packet (AP) provides information regarding the number of null and/or nonessential packets from the original transport stream that it
30 replaces. It may also contain a timecode which

describes the location of the next program access unit
(e.g., the next audio or video packet) within the
event, allowing the Data Stream Player to identify
transport packets indicated to be erroneous (e.g., via

5   the packets' transport_error_indicator bit) and
replace them if and when the correct packets are
received. As known from the MPEG-2 standard,
transport_error_indicator is a one-bit flag. When set
to '1', the flag indicates that at least one

10   uncorrectable bit error exists in the associated TS
packet.

The annotation packet may also contain
information to facilitate user navigation (e.g., the
location of the next I-frame for fast-forward/rewind

15   operation, the location of the next scene in a movie,
the start of the next song, etc.).

The Data Stream Generator may encrypt the non-
real-time packets. In one aspect of the invention,
packets generated by the Nonessential Packet

20   Extraction and Annotation Packet Generator 130 are
encrypted using a key for which authorization data,
such as an entitlement management message (EMM), is
not distributed to the Data Stream Player until some
future time, allowing future concurrent activation of

25   all Data Stream Players.

An example of the use of annotation packets in
accordance with the invention is seen by referring to
the streams 400 and 410. Annotation packets contain
program-specific information and are conveyed via a

30   unique packet identifier (PID). Each annotation

packet describes the number and location of null and/or nonessential packets (i.e., packets not associated with the selected program stream) within the original transport stream. For example, $AP_{1,1}$ may

5   include information indicating that three null and/or nonessential packets ($N/N_{1,1}$ through $N/N_{1,3}$) are provided prior to the first (next) program packet ($A_{1,1}$), that two additional null and/or nonessential packets ($N/N_{1,4}$ and $N/N_{1,5}$) are provided prior to the

10   second next program packet ($V_{1,5}$), and that two further null and/or nonessential packets ($N/N_{1,6}$ and $N/N_{1,7}$) are provided prior to the sixth next program packet ($V_{1,8}$).

        Annotation packets may also include information to describe the original transport packet rate and

15   identify the location of packets within a program. For example, a time code or codes may be included in the annotation packet to facilitate navigation to user-specified times. Such a time code may also be useful in locating and replacing packets received

20   erroneously (e.g., in applications where the Data Stream is repeated or "carouseled"). Annotation packets may contain all, or a portion, of an Annotation message formatted as a private section using the following example syntax:

Table 1: Annotation Section

Syntax	No. of bits	Mnemonic
annotation_section() {		
table_id	8	uimsbf
section_syntax_indicator	1	bslbf
private_indicator	1	bslbf
reserved	2	bslbf
section_length	12	uimsbf
for (		
i=0;I<section_length-4;i++) {		
descriptors( )	8	bslbf
}		
checksum	32	uimsbf
}		

section_syntax_indicator is set to '0', indicating

that private data bytes exist immediately following

the section_length field.

checksum is set as defined by ISO/IEC 13818-6. It is

calculated over the entire section.

The following descriptors are defined for use in

the annotation section:

Table 2: Null Packet Identifier Descriptor

Syntax	No. of bits	Mnemonic
null_packet_identifier_descriptor() {		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
number_of_null_packets_string	N*8	uimsbf
}		

number_of_null_packets_string is a string of bytes

that describe the number of null or nonessential

packets (in the original transport stream) that

precede each of the service packets following the annotation packet that contains this descriptor and prior to the next annotation packet. Values are represented as follows:

5
    0x00-0xFE: 0-254

    0xFF00-0xFFFE   255-509

    0xFFFF00-0xFFFFFE   510-764

    etc.

A value of zero indicates that no null or nonessential
10 packets exist. A value of 0xFF is used as an escape code to extend the length of this field to describe null packet sequences in excess of 254 bytes. Each subsequent value of 0xFF describes an additional 255 bytes of null or nonessential packets.

15 For example, a number_of_null_packets_string value of 0x1000FFFF0300FE0A indicates the following:

- The 1st service packet following the annotation section is preceded by sixteen null and/or nonessential packets in the original transport
20 stream.

- The 2nd service packet is preceded by zero null and/or nonessential packets (i.e., it is contiguous with the 1st service packet).

- The 3rd service packet is preceded by 513
25 (255+255+3) null and/or nonessential packets.

- The 4th service packet is preceded by zero null and/or nonessential packets (i.e., it is contiguous with the 3rd service packet).

- The 5th service packet is preceded by 254 null and/or nonessential packets.

- The 6th service packet is preceded by 10 null and/or nonessential packets.

The null_packet_identifier_descriptor may describe up to descriptor_length subsequent service packets. In typical applications (where the occurrence of 255 contiguous null or non-service packets is rare), an annotation packet can describe up to 174 service packets. This represents a transmission and/or storage overhead of 0.57%. This can be seen by noting that the maximum size of a null_packets_string, if contained entirely within one 188-byte annotation packet, is 174 bytes. So, in the best case, one annotation packet may be used to describe the number of N/N packets that precede each of up to 174 packets. The best case means the number of contiguous N/N packets between each service packet is less than 255; this is typically the case. So, one AP can describe up to 174 service packets, and 1/174 = 0.00575 or 0.57% is the overhead.

Table 3: Transport Packet Rate Descriptor

Syntax	No. of bits	Mnemonic
transport_packet_rate_descriptor() {		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
transport_packet_rate	32	uimsbf
}		

transport_packet_rate is the original transport packet
rate in bits per second and is optional. It may be
used by the Data Stream Player to control its output

5   transport stream rate.

It should now be appreciated that the present
invention provides a system for extracting programs
from single and multiple-program transport streams for
subsequent non-real-time ("background") transmission

10   in a bandwidth-efficient manner. Such "programs" may
include anything from targeted commercial
advertisements to broadcast full-length movies. A non
-real-time program is formed from a real-time
transport stream by providing annotation packets that

15   describe the original packet separation (timing) of
the program. The non-real-time packets are inserted
into a real-time transport stream by replacing null
packets therein. At a decoder, the annotation packets
are used to maintain the proper spacing between the

20   program packets.

A system is also provided for delivering pre-
encrypted programs in non-real-time. In this case,
entitlement control messages (ECMs) may be included;
however, entitlement management messages (EMMs)

25   necessary to decrypt a program or programs may not be

distributed until some future time specified by the
program provider. This allows mass distribution for
storage prior to a formal program "release." After
"release" of the content, the decoder, if authorized,

5   is permitted to decrypt the program(s).

Although the invention has been described in
connection with a preferred embodiment, numerous
adaptations and modifications may be made thereto
without departing from the scope of the invention as

10   set forth in the claims.

What is claimed is:

1.   A method for providing data of at least a first program of a first data stream in an input transport stream, said transport stream comprising data of at least a second data stream, comprising the steps of:

extracting at least one of null packets and nonessential packets of the first data stream;

providing at least one annotation packet that provides information regarding the extracted packets; and

inserting the at least one annotation packet and program packets of the first program into the input transport stream in place of null packets of the second data stream to form an output transport stream.

2.   The method of claim 1, wherein:

the second data stream is provided in real-time in the input and output transport streams.

3.   The method of claim 1, wherein:

the program packets of the first program are provided in non-real-time in the output transport stream.

4.   The method of claim 1, wherein:

the program packets of the first program are obtained from the input transport stream.

5.   The method of claim 1, wherein:

the program packets of the first program are obtained from a transport stream that is different than the input transport stream.

6.   The method of claim 1, wherein:

the program packets of the first program are obtained from a storage device.

7.   The method of claim 1, comprising the further step of:

transcoding the program packets of the first program prior to said inserting step.

8.   The method of claim 1, wherein:

packets of at least one additional program are inserted into the input transport stream in place of null packets of the second data stream to form the output transport stream.

9.   The method of claim 1, wherein:

the at least one annotation packet is provided with its own packet identifier to enable identification thereof by a decoder.

10.   The method of claim 1, wherein:

the information regarding the extracted packets indicates a number of the null and/or nonessential packets in the first data stream.

11.   The method of claim 1, wherein:

the information regarding the extracted packets indicates a location of the null and/or nonessential packets in the first data stream.

12.   The method of claim 1, wherein:

the at least one annotation packet comprises a time code that is usable in replacing a first packet copy that is received erroneously by a decoder by a second packet copy that is subsequently transmitted to the decoder.

13.   The method of claim 1, wherein:

a plurality of annotation packets are provided and inserted into the input transport stream; and

each annotation packet provides information regarding a respective group of extracted null and/or nonessential packets.

14.   The method of claim 1, wherein:

the nonessential packets comprise program data from a program that is not desired to be recovered.

15.   The method of claim 1, wherein:

the at least one annotation packet contains a time code that describes a location of at least one subsequent program packet in the first program.

16.   The method of claim 15, wherein:

the time code is adapted to be used by a decoder
that receives the output transport stream to identify
and replace erroneous packets of the output transport
stream.

17. The method of claim 1, wherein:
the at least one annotation packet comprises
facilitating information to facilitate playback of the
first program at a decoder.

18. The method of claim 17, wherein:
the facilitating information comprises time code
data.

19. The method of claim 17, wherein:
the facilitating information designates a
location of a next I-frame in the first program for
fast-forward/rewind operations.

20. The method of claim 17, wherein:
the facilitating information designates a
location of a next scene in the first program.

21. The method of claim 17, wherein:
the facilitating information designates a
location of a next audio passage in the first program.

22. The method of claim 1, comprising the
further step of:

communciating the output transport stream to at
least one decoder;

at the decoder, recovering at least some of the
program packets of the first program, and storing the
recovered packets at a storage device; and

retrieving the stored packets for playback on an
output device in accordance with a control signal.

23. The method of claim 22, comprising the
further step of:

at the decoder, recovering data from the at least
one annotation packet that indicates a bit rate for
playing back the stored packets.

24. The method of claim 22, wherein:

the control signal is provided in accordance with
a user who is local to the decoder.

25. The method of claim 22, wherein:

the control signal is provided by a provider
associated with the output transport stream who is
remote from the decoder.

26. The method of claim 22, wherein the program
packets of the first program comprise encrypted data,
comprising the further step of:

providing authorization data to the decoder to
enable the decoder to decrypt the encrypted data at a
specified time after the program packets of the first

program have been recovered and stored at the storage
device.

27.   The method of claim 22, comprising the
further steps of:

at the decoder, recovering the at least one
annotation packet from the output transport stream;
and

regenerating a number of null packets in
accordance with the at least one recovered annotation
packet to provide regenerated data that is suitable
for decoding.

28.   An apparatus for providing data of at least
a first program of a first data stream in an input
transport stream, said transport stream comprising
data of at least a second data stream, comprising:

means for extracting at least one of null packets
and nonessential packets of the first data stream;

means for providing at least one annotation
packet that provides information regarding the
extracted packets; and

means for inserting the annotation packet and
program packets of the first program into the input
transport stream in place of null packets of the
second data stream to form an output transport stream.

29.   A method for processing an output transport
stream received at a decoder, wherein the output
transport stream comprises data of at least a first

program and a second data stream, comprising the steps
of:

recovering program packets of the first program;

storing the recovered packets at a storage
device;

recovering at least one annotation packet from
the output transport stream; and

regenerating a number of null packets of the
first program in accordance with the recovered
annotation packet to provide regenerated data that is
suitable for decoding; wherein:

the output transport stream is formed at an
encoder by extracting at least one of null packets and
nonessential packets of a first data stream that
carries the first program, wherein the at least one
annotation packet provides information regarding the
extracted packets, and inserting the at least one
annotation packet and the program packets of the first
program into an input transport stream in place of
null packets of the second data stream.

30.   The method of claim 29, comprising the
further step of:

recovering data from the at least one annotation
packet that indicates a bit rate for playing back the
stored packets.

31.   The method of claim 29, wherein:

the program packets of the first program comprise
encrypted data; and

authorization data is provided to the decoder to
enable the decoder to decrypt the encrypted data at a
specified time after the program packets of the first
program have been recovered and stored at the storage
device.

32. The method of claim 29, wherein:
program packets of the second data stream are
provided in real-time in the input and output
transport streams.

33. The method of claim 29, wherein:
the program packets of the first program are
provided in non-real-time in the output transport
stream.

34. The method of claim 29, wherein:
packets of at least one additional program are
inserted into the input transport stream in place of
null packets of the second data stream to form the
output transport stream.

35. The method of claim 29, wherein:
the at least one annotation packet has its own
packet identifier for enabling its recovery from the
output transport stream.

36. The method of claim 29, wherein:

the information regarding the extracted packets indicates a number of the null packets and/or nonessential packets in the first data stream.

37. The method of claim 29, wherein:

the information regarding the extracted packets indicates a location of the null packets and/or nonessential packets in the first data stream.

38. The method of claim 29, wherein:

the at least one annotation packet comprises a time code that is usable in replacing a first packet copy that is received erroneously by a second packet copy that is subsequently received.

39. The method of claim 29, wherein:

a plurality of annotation packets are provided and inserted into the input transport stream; and

each annotation packet provides information regarding a respective group of extracted null packets and/or nonessential packets.

40. The method of claim 29, wherein:

the nonessential packets comprise program data from a program that is not desired to be recovered.

41. The method of claim 29, wherein:

the at least one annotation packet contains a time code that describes a location of at least one subsequent program packet in the first program.

42.   The method of claim 41, wherein:

the time code is used to identify and replace erroneous packets of the output transport stream.

43.   The method of claim 29, comprising the further step of:

retrieving the stored packets for playback on an output device in accordance with a control signal.

44.   The method of claim 43, wherein:

the control signal is provided in accordance with a user who is local to the decoder.

45.   The method of claim 43, wherein:

the control signal is provided by a provider associated with the output transport stream who is remote from the decoder.

46.   The method of claim 29, wherein:

the at least one annotation packet comprises facilitating information to facilitate playback of the first program.

47.   The method of claim 46, wherein:

the facilitating information designates a location of a next audio passage in the first program.

48.   The method of claim 46, wherein:

the facilitating information comprises time code
data.

49.   The method of claim 46, wherein:
the facilitating information designates a
location of a next I-frame in the first program for
fast-forward/rewind operations.

50.   The method of claim 46, wherein:
the facilitating information designates a
location of a next scene in the first program.

51.   A decoder for processing an output transport
stream received thereat, wherein the output transport
stream comprises data of at least a first program and
a second data stream, comprising:
means for recovering program packets of the first
program;
a storage device for storing the recovered
packets;
means for recovering at least one annotation
packet from the output transport stream; and
means for regenerating at least one of null
packets and nonessential packets of the first program
in accordance with the recovered at least one
annotation packet to provide regenerated data that is
suitable for decoding; wherein:
the output transport stream is formed at an
encoder by extracting the null packets and/or
nonessential packets of a first data stream that

carries the first program, wherein the at least one
annotation packet provides information regarding the
extracted packets, and inserting the at least one
annotation packet and the program packets of the first
program into an input transport stream in place of
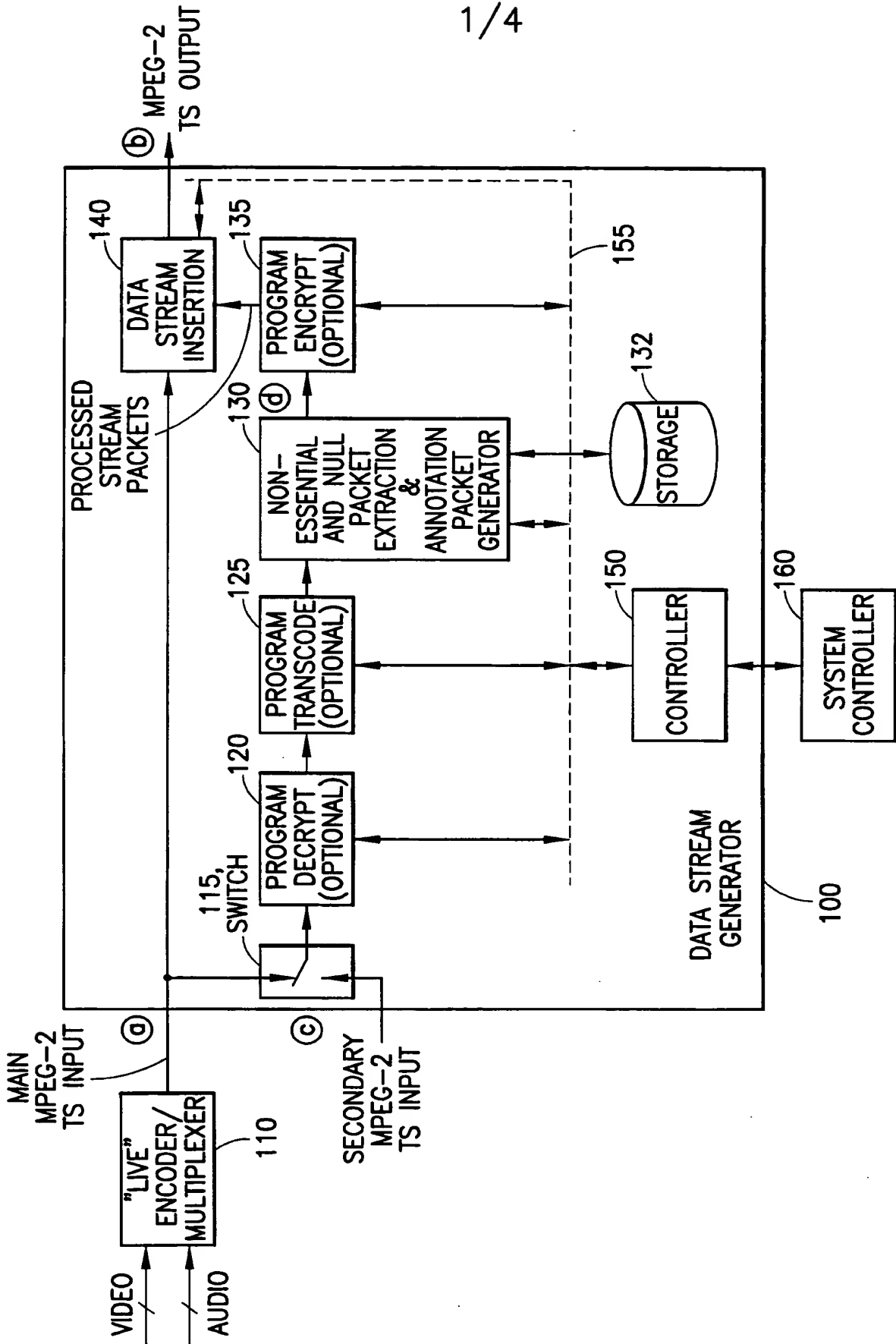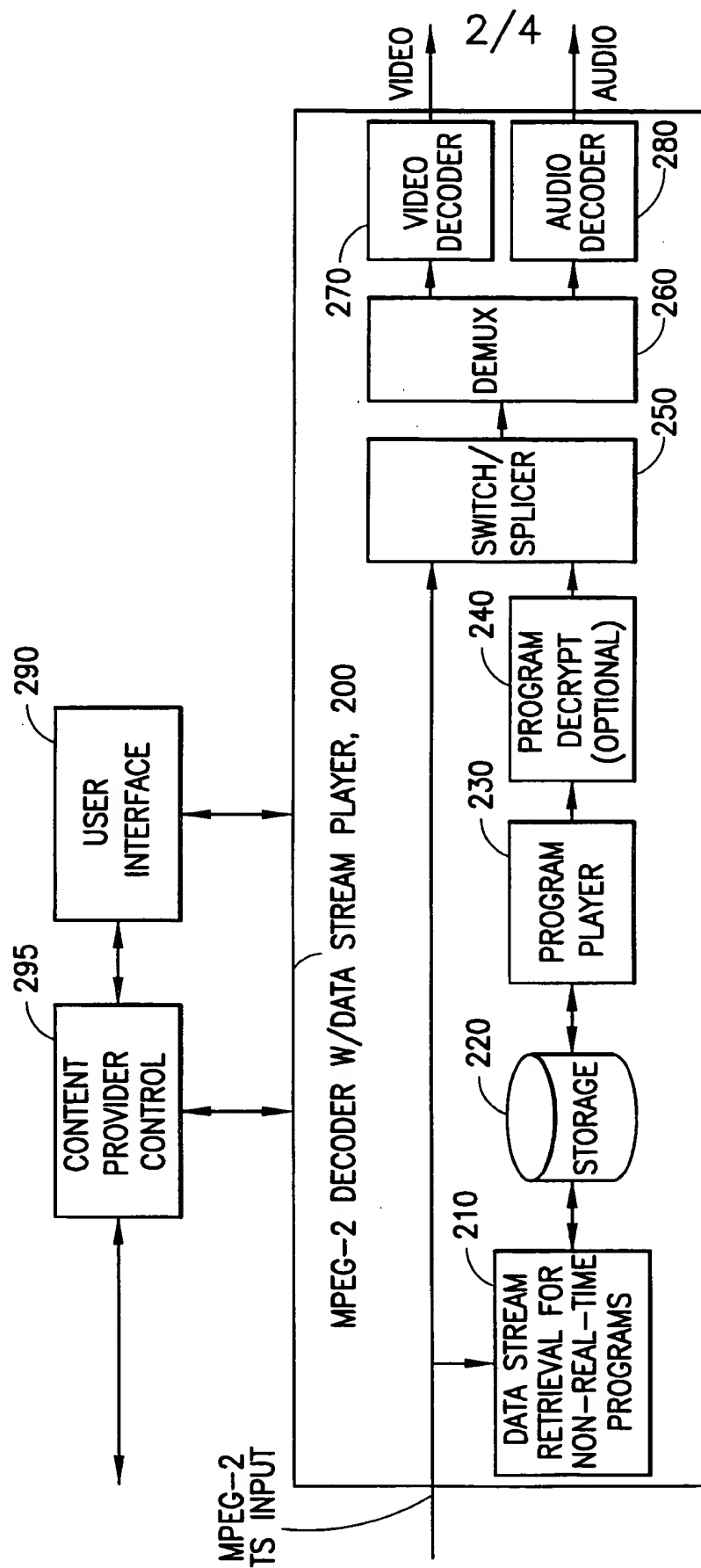null packets of the second data stream.
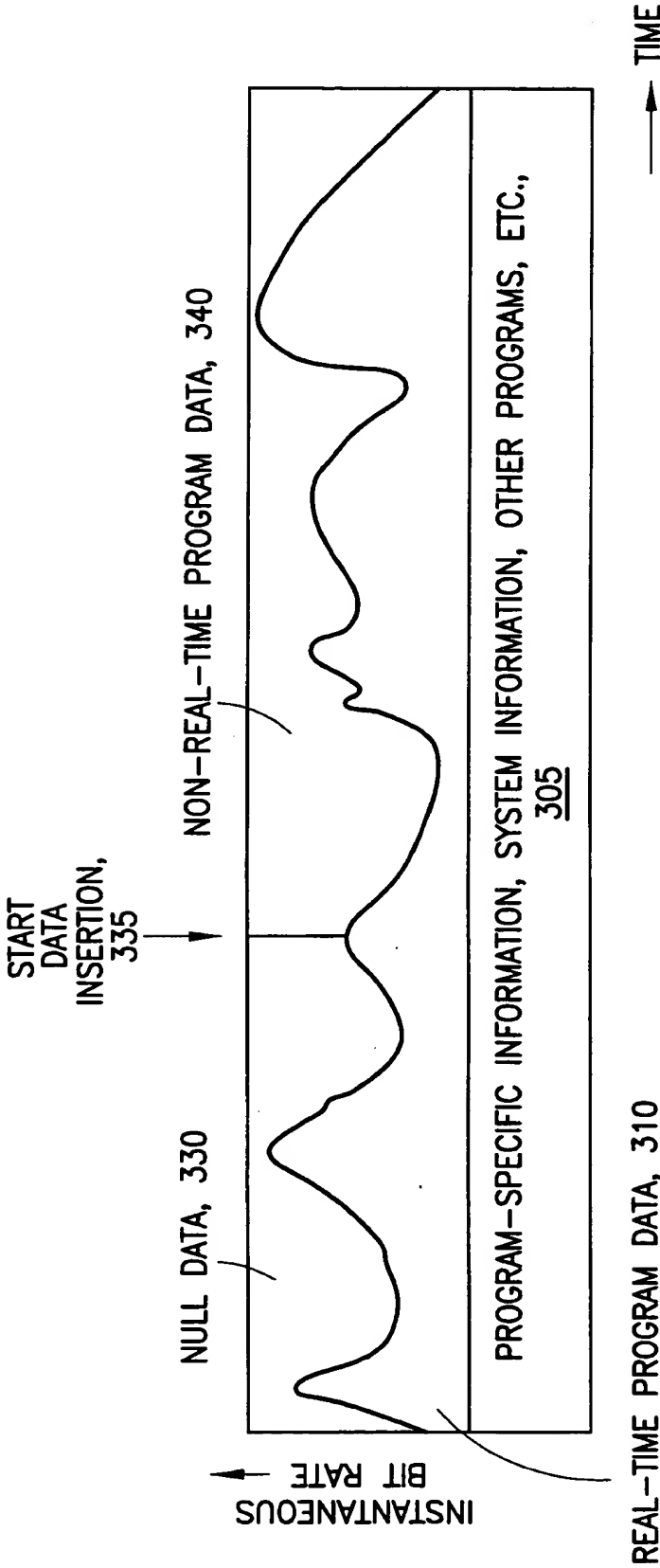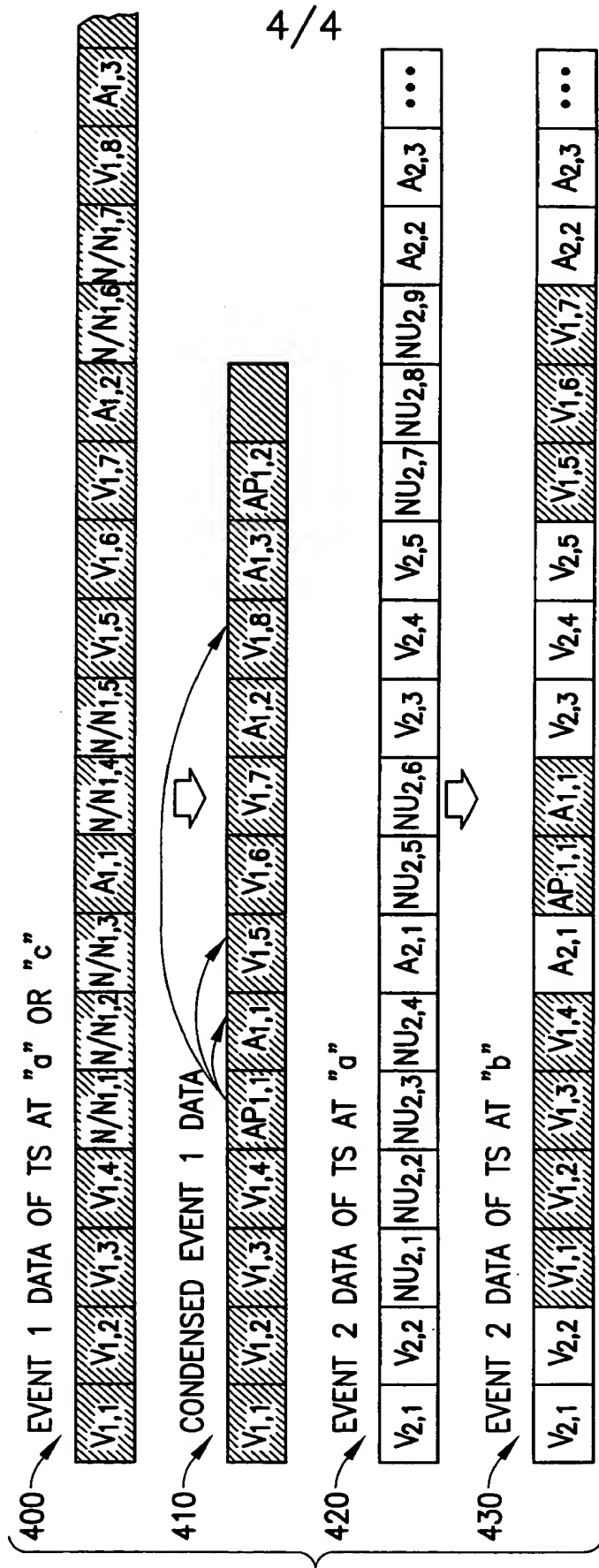
FIG.1

2/4

FIG.2

3/4

FIG.3

4/4

FIG.4